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FUEL CONTAINER FOR FUEL CELL

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a fuel container for housing and directly supplying fuel, such as methanol solution, to a fuel cell, such as a polymer electrolyte fuel cell (PEFC). The present invention also relates to a fuel container for reinjecting fuel into a fuel container, which is mounted on a fuel cell.

Description of the Related Art

Conventional containers for housing solutions include aerosol containers, and cosmetic containers, for example. Generally, glass, metal, or plastic is used as the material of the main bodies of the containers. These containers are pressurized such that when nozzles thereof are opened, the solutions stored therein are sprayed out for use.

In the containers described above, springs are utilized as urging members for urging the nozzles in the closing direction. From the viewpoints of cost and ease of use, metallic coil springs are generally used. However, in order to improve recycling rates, cylindrical urging members constituted by elastic resin materials have been proposed (refer to Japanese Unexamined Patent Publication No. 11(1999)-90282, for example).

The use of fuel cells as miniature power sources for devices such as portable computers (laptop PC's, PDA's and the like) is being contemplated. Fuel containers are necessary to supply fuel to these fuel cells. In the case that the fuel cell is a polymer electrolyte fuel cell (hereinafter, referred to simply as PEFC), methanol and distilled water, ethanol and distilled water, pure methanol, or pure ethanol is used as the fuel therefor. In addition, dimethyl ether is expected to be used as fuel for solid oxide fuel cells (hereinafter, referred to simply as SOFC) and PEFC's.

However, in fuel cells such as SOFC's and PEFC's, contamination by metallic ions is to be avoided. It has been found, therefore, that the fuel container must be constructed such that metallic ions do not contaminate fuel housed therein.

It is inappropriate to employ metallic materials for members that contact the fuel, because ions will be generated. Even if the metallic members are coated with resin, generation of ions cannot be avoided, due to pinholes in the resin film. In the case that interior pressure is applied to the fuel container such that the fuel is ejected and supplied, it is not preferable for the fuel to be supplied contaminated by the pressurizing agent (propellant).

The shape of the fuel container is set according to the shape of the fuel cell itself, or the shape of a fuel container housing portion of a device, such as a laptop PC. Therefore, it is disadvantageous from the viewpoint of cost to dispose of fuel containers, which have been provided in shapes according to specific devices, once the fuel therein is consumed. In addition, such fuel containers easily become difficult to obtain, which is inconvenient.

SUMMARY OF THE INVENTION

The present invention has been developed in view of the aforementioned points. It is an object of the present invention to provide a fuel container for fuel cells that prevents contamination of fuel by metallic ions and propellant, and which is reusable. It is another object of the present invention to provide a fuel container that reinjects fuel into fuel containers, which are mounted on fuel cells.

A first fuel container for housing fuel to be supplied to a fuel cell of the present invention comprises:

a container main body having a sealed structure;

an inner container for housing the fuel therein, formed by a flexible bag provided within the container main body;

a valve mechanism for enabling/disabling supply of fuel,

provided in the container main body and in communication with the interior of the inner container;

an injection valve for injecting fuel, provided in the container main body and in communication with the interior of the inner container; and

compressed gas for ejecting the fuel, sealed between the container main body and the inner container;

all of the structural components that contact the fuel being formed of non-metallic materials; and

the fuel container being mountable on the fuel cell to directly supply fuel thereto.

A second fuel container for housing fuel to be supplied to a fuel cell of the present invention comprises:

a container main body having a sealed structure;

an inner container for housing the fuel therein, formed by a flexible bag provided within the container main body;

a valve mechanism for enabling/disabling supply of fuel and for injecting fuel, provided in the container main body and in communication with the interior of the inner container; and

compressed gas for ejecting the fuel, sealed between the container main body and the inner container;

all of the structural components that contact the fuel being formed of non-metallic materials; and

the fuel container being mountable on the fuel cell to directly supply fuel thereto.

A third fuel container for housing fuel to be supplied to a fuel cell of the present invention comprises:

a container main body having a sealed structure;

an inner container for housing the fuel therein, formed by a flexible bag provided within the container main body;

a valve mechanism for enabling/disabling supply of fuel, provided in the container main body and in communication with the interior of the inner container; and

compressed gas for ejecting the fuel, sealed between the container main body and the inner container at a pressure higher

than a fuel pressure of a fuel container, which is mounted on the fuel cell to directly supply fuel thereto;

all of the structural components that contact the fuel being formed of non-metallic materials; and

the fuel container being mountable on the fuel container, which is mounted on the fuel cell, to reinject fuel therein.

A fourth fuel container for housing fuel to be supplied to a fuel cell of the present invention comprises:

a cylindrical container main body for housing the fuel therein;

a piston shaped extruding member, which is manually operated to slide within the container main body in an airtight manner so as to pressurize the fuel;

a valve mechanism for enabling/disabling supply of fuel, provided in the container main body;

all of the structural components that contact the fuel being formed of non-metallic materials; and

the fuel container being mountable on a fuel container, which is mounted on the fuel cell, to reinject fuel therein.

It is preferable for the container main body of each of the above fuel containers to be formed by a transparent material.

The fuel containers of the present invention are suited to house fuels for PEFC's, such as methanol and distilled water, ethanol and distilled water, pure methanol, and pure ethanol. The fuel containers of the present invention may also be utilized to house fuel for SOFC's and PEFC's, such as dimethyl ether.

Each of the fuel containers of the present invention comprises: a container main body; an inner container for housing fuel; and a valve mechanism for enabling/disabling supply of fuel. All of the structural components that contact the fuel are formed by non-metallic materials, and compressed gas is sealed between the container main body and the inner container. Therefor, only the fuel can be ejected and supplied. Further,

contamination by metallic ions can be prevented, because the housed fuel does not contact any metal. Particularly, in fuel cells such as PEFC's, contamination of fuel, such as methanol solution and ethanol solution by metallic ions is to be avoided. By forming the members that contact the fuel with non-metallic materials, the release of metallic ions can be avoided. Thereby, fuel containers to be mounted onto fuel cells to directly supply fuel thereto, and fuel containers to reinject fuel to fuel containers, which are mounted onto fuel cells, can be produced without decreasing the performance of the fuel cells.

That is, in the case that the fuel container comprises an injection valve, through which fuel can be reinjected, or if the valve mechanism is configured to enable both supply and injection, users can easily refill the fuel container, by utilizing a fuel container configured to reinject fuel. This is advantageous from the viewpoint of cost, and the degree of freedom regarding shapes corresponding to devices is improved. In addition, additional fuel will become commonly available, by providing universal reinjecting fuel containers, which will improve convenience.

Particularly in fuel containers that comprise injection valves separate from the valve mechanism to be connected to fuel cells, it is possible to reinject fuel through the injection valves while the fuel containers are mounted on the fuel cells. On the other hand, in fuel containers that comprise valve mechanisms that enable both supply and injection of fuel, it is necessary to disconnect the fuel containers from fuel cells to reinject fuel therein. However, separate injection valves can be omitted, simplifying the structure of the fuel containers.

In the third fuel container of the present invention, compressed gas for ejecting the fuel is sealed between the container main body and the inner container at a pressure higher than a fuel pressure of a fuel container, which is mounted on the fuel cell to directly supply fuel thereto. The fourth fuel

container of the present invention comprises: a cylindrical container main body for housing the fuel therein; and a piston shaped extruding member, which is manually operated. The third and fourth fuel containers are capable of reinjecting fuel into fuel containers that directly supply fuel to fuel cells. The shapes of the third and fourth fuel containers can be set as desired. The third and fourth fuel containers can be constructed according to considerations regarding fuel capacity and portability, thereby improving convenience.

The container main body of each of the fuel containers of the present invention may be formed by a transparent material. In this case, the amount of remaining fuel and states of reinjection can be visually confirmed.

In addition, forming the fuel containers from resin exhibits the following advantageous effects. The fuel containers may be formed into various shapes, such as cylinders, polygons, ovals, and the like. Classification during disposal is facilitated, which is suitable for recycling. Thermal properties are favorable compared to metal, which is cold to the touch. Changes in the contents due to corrosion are not likely to occur.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic sectional view illustrating a fuel container to be mounted on a fuel cell, according to a first embodiment of the present invention.

Figure 2A is a sectional view of the main parts of a valve mechanism.

Figure 2B is a sectional view of the main parts of an alternate valve mechanism.

Figure 3 is a schematic sectional view illustrating a fuel container to be mounted on a fuel cell, according to a second embodiment of the present invention.

Figure 4 is a schematic sectional view illustrating a fuel container for reinjecting fuel, according to a third embodiment

of the present invention.

Figure 5 is a schematic sectional view illustrating a fuel container for reinjecting fuel, according to a fourth embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, embodiments of the present invention will be described in detail with reference to the attached drawings. Figure 1 is a schematic sectional view illustrating a fuel container 1 to be mounted on a fuel cell, according to a first embodiment of the present invention. Figures 2A and 2B are sectional view of main parts of valve mechanisms.

The fuel container 1 of the first embodiment houses a methanol/distilled water solution at a predetermined concentration, a ethanol/distilled water solution at a predetermined concentration, pure methanol, or pure ethanol as fuel F. The fuel container 1 supplies the fuel F to PEFC's and the like. The fuel container 1 is mounted onto a fuel cell main body (not shown). It is possible to reinject fuel into the fuel container 1 by using reinjecting fuel containers 10, 20 to be described later, and to use the fuel container 1 repeatedly.

As illustrated in Figure 1, the fuel container 1 comprises: an outer container main body 2; an inner container 3 for housing the fuel F therein, formed by a flexible bag provided within the container main body 2; a valve mechanism 4 for opening and closing an upper supply opening 2a that communicates the interior of the inner container 3 with the exterior of the container main body 2 to supply fuel; an injection valve 5 for opening and closing a lower injection opening 2b, provided opposite the supply opening 2a, that communicates the interior of the inner container 3 with the exterior of the container main body 2, through which fuel is injected; and a dip tube 6, which is inserted into the interior of the inner container 3 from the valve mechanism 4. All of the parts, and particularly the parts that contact the fuel F,

are formed by non-metallic materials, that is, resin. The space between the container main body 2 and the inner container 3 is airtight, and compressed gas G for applying ejection pressure for the fuel F to the inner container 3 is sealed in this space.

The container main body 2 is formed as a sealed box. The shape of the container main body 2 is set according to the shape of the fuel cell main body (not shown), or to the shape of a fuel container housing portion of a device, such as a laptop PC, in which the fuel cell is mounted. The shape can be varied as desired, in order to secure a predetermined inner capacity. The structure and wall thickness of the container main body 2 are designed to have compressive strength capable of withstanding the pressure of the contents. The outer container main body 2 is formed by a transparent material, such as transparent PC, PAN, PEN, PET, and the like, such that the amount of fuel F remaining within the inner container 3 can be visually confirmed.

Meanwhile, the inner container 3 has resistance with respect to the fuel F. A bag, formed by sheets of rubber film, PAN, PEN or the like, which are coated with ceramic by vapor deposition and sealed together, or formed by sheets of PE, PP or the like, which are coated with metal foil (aluminum foil, for example) and sealed together, is fixed to the supply opening 2a and the injection opening 2b of the container main body 2 in a sealed state. The inner container 3 is impermeable with respect to gases. The volume of the inner container 3 is set such that a fuel housing ratio with respect to the entire volume of the container main body 2 is maximized.

Air, nitrogen, or carbon dioxide is employed as the compressed gas G, which is sealed between the container main body 2 and the inner container 3. In the case that a gas that does not contain oxygen, such as nitrogen, is employed, oxidation of the fuel F (particularly methanol) by trace amounts of oxygen that permeates through the inner container 3 can be prevented. By employing compressed gas, variations in

pressure due to temperature change of the container main body are reduced, compared to cases in which liquefied gas is employed.

The valve mechanism 4 is provided within the supply opening 2a, which is formed as a protrusive cylinder at a portion (the upper portion in Figure 1) of the container main body 2. Specific examples of the valve mechanism will be described with reference to Figure 2A and Figure 2B. The valve mechanism 4 comprises a flow rate adjusting mechanism 7 and a resistance mechanism 8. In the example illustrated in Figure 2A, the flow rate adjusting mechanism 7 (the detailed structure of which is not shown) is provided at the open portion of the supply opening 2a of the container main body 2 (the portion that connects with the fuel cell), and the valve mechanism 4 is provided beneath the flow rate adjusting mechanism 7. On the other hand, in the example illustrated in Figure 2B, the valve mechanism 4 is provided at the open portion of the supply opening 2a of the container main body 2 (the portion that connects with the fuel cell), and the rate adjusting mechanism 7 is provided beneath the valve mechanism 4. The basic structure of the valve mechanism 4 is the same between the examples of Figure 2A and Figure 2B, and will be described employing the same reference numerals.

The valve mechanism 4 comprises: a guiding screw 41 for fixing the valve mechanism to the container main body 2; a gasket 42 for enabling/disabling supply of the fuel F by functioning as a valve; a valve stem 43, which is the operating member that opens and closes the valve; a resin spring 44 that functions as an urging member for urging the valve stem 43 in the closing direction; and a valve housing 45 for housing the resin spring 44. All of the above components are formed by non-metallic materials.

The valve housing 45 is mounted onto the supply opening 2a of the container main body 2. In the example of Figure 2B, the flow rate adjusting mechanism 7 is built in to the bottom

of the valve housing 45 in advance. Assembly of the valve mechanism 4 will be described. The resin spring 44 is inserted into the valve housing 45, the valve stem 43 is inserted atop the resin spring 44, the gasket 42 is fitted about the outer periphery of the valve stem 43, and the guide screw 41 is threadedly engaged with the container main body 2 to build the valve mechanism 4 into the container main body 2. The valve stem 43 is urged by the resin spring 44 toward the guide screw 41, and the outer periphery of the gasket 42 is held and fixed to the container main body 2 by the guide screw 41.

A peripheral groove is formed in the outer periphery of the valve stem 43. Fine openings, which are open at the bottom of the peripheral groove, communicate with a central path, and the central path opens into an upper ejection opening. The gasket 42 is fitted into the peripheral groove of the valve stem 43. Elastic close contact of the inner peripheral surface of the gasket 42 seals the fine openings, to shut off supply of the fuel F. When the fuel container 1 is connected to the fuel cell, the valve stem 43 is pressed inward against the resin spring 44, via the flow rate adjusting mechanism 7 in the example of Figure 2A, and directly in the example of Figure 2B. Accompanying the downward movement of the valve stem 43, the inner peripheral portion of the gasket 42 deforms to open the fine openings. Thereby, the fuel F is supplied into the valve housing 45 by the dip tube 6, via the flow rate adjusting mechanism 7, in the example of Figure 2B. Then, the fuel F, which has flowed into the valve housing 45, is supplied to the fuel cell via the central path of the valve stem 43, via the flow rate adjusting mechanism 7 in the example of Figure 2A, and directly in the example of Figure 2B.

The resin spring 44 that functions as the urging member comprises: a discoid base for holding the position of the lower end; an abutting portion for abutting the bottom of the valve stem 43 to transfer urging force thereto; and a folded deforming portion that links the base and the abutting portion. The resin

spring 44 is molded from polyacetal (POM), for example.

A compressive structure of a filter constitutes the flow rate adjusting mechanism 7, for example. A filter formed by urethane foam may be provided in a fuel flow path in a compressed state. The flow rate of the fuel F may be adjusted by varying the compression of the filter. Thereby, abrupt ejection of the fuel F is suppressed, and the load on a flow rate adjusting mechanism of the fuel cell is reduced. In addition, the resistance mechanism 8 is provided in the valve mechanism 4, to prevent inadvertent opening operations thereof. In the examples illustrated in Figure 2A and Figure 2B, the periphery of the edge of the supply opening 2a is formed toward the exterior of the tip of the valve stem 43, to constitute the resistance mechanism 8. The resistance mechanism 8 prevents other members from contacting the tip of the valve stem 43.

The injection valve 5 is of the same basic structure as the valve mechanism 4. However, the flow rate adjusting mechanism 7 may be omitted from the injection valve 5.

The fuel container 1 described above ejects the fuel F with a pressure within a predetermined range. The fuel container 1 is of a double structure comprising the container main body 2 and the inner container 3, so as to prevent contents other than the fuel F from being ejected. Therefore, fuel leaks due to shocks, imparted by the fuel container 1 being dropped or the like, can be prevented. In addition, the fuel container 1 can adapt to the requirements for high space efficiency demanded in laptop PC's and PDA's. A compact fuel container having a large capacity can be realized. In addition, the fuel container 1 comprises the injection valve 5 separate from the valve mechanism 4. Therefore, fuel can be reinjected into the fuel container 1, without removing it from the fuel cell.

The fuel container 1 of the first embodiment suited to house fuels such as methanol and distilled water, ethanol and distilled water, pure methanol, and pure ethanol. The fuel container 1 of the first embodiment may also be utilized to house

fuel for SOFC's and PEFC's, such as dimethyl ether. Dimethyl ether is gaseous at room temperature, but may be compressed into liquefied gas and injected into the fuel container 1. In this case, the liquefied dimethyl ether itself possesses ejection pressure. Therefore, compressed gas need not be sealed between the container main body 2 and the inner container 3. Liquefied dimethyl ether exerts high pressure, which necessitates a pressure resistant construction. In addition, a construction which is resistant to solubility due to the dimethyl ether is also necessary. The fuel container 1 is of a double structure. Accordingly, the inner container 3 may be of a construction that is resistant against solubility by dimethyl ether, and also leak proof, while the container main body 2 may be of a construction which is resistant to cracking and deformation due to pressure.

Figure 3 is a schematic sectional view illustrating a fuel container 1' according to a second embodiment of the present invention. The function of the injection valve 5 of the first embodiment is imparted to the valve mechanism 4 at the supply opening 2a in the fuel container 1', and a separate injection valve is omitted. The other structures of the fuel container 1' are the same as those of the fuel container 1 of the first embodiment. The following description will employ the same reference numerals as those of the first embodiment for common structures, and detailed descriptions thereof will be omitted.

In the second embodiment, supply of the fuel F to the fuel cell and reinjection of fuel into the fuel container 1' are performed through opening and closing operations of the valve mechanism 4 illustrated in Figure 2A and 2B. When reinjecting fuel, it is necessary to remove the fuel container 1' from the fuel cell. However, the structure of the fuel container 1' is simplified.

In the fuel containers 1 and 1' of the first and second embodiments, to be mounted onto the fuel cell, the parts that contact the fuel F are formed by resin. Thereby, metallic ions do not contaminate the fuel F for fuel cells, such as methanol

solution and ethanol solution. In addition, there is no contamination of the fuel F by propellant. Accordingly, a favorable fuel container for PEFC's, for which the presence of metallic ions is to be avoided, can be realized. The fuel containers 1 and 1' do not decrease the performance of the fuel cell, and can be utilized repeatedly, by reinjecting fuel therein.

Figure 4 and Figure 5 are schematic sectional views of injecting fuel containers 10 and 20 according to a third and fourth embodiments of the present invention, respectively. The injecting fuel containers 10 and 20 are utilized to reinject fuel into the inner containers 3 of the fuel containers 1 and 1', when the amount of fuel therein decreases.

The injecting fuel container 10 illustrated in Figure 4 comprises: a container main body 12; an inner container 13 formed by a flexible bag; a valve mechanism 14 (nozzle mechanism); a resistance mechanism 15; and a dip tube 16. The basic construction of the injecting fuel container 10 is the same as that of the fuel containers 1 and 1'. Fuel F is housed in the interior of the inner container 13, and compressed gas G for applying ejection pressure is sealed between the container main body 12 and the inner container 13. The valve mechanism 14 is configured to be connected to the injection valve 5 of the fuel container 1 or to the valve mechanism 4 of the fuel container 1', to inject the fuel F into the fuel container 1 or 1' by the pressure applied by the compressed gas G.

The pressure of the compressed gas G, which is sealed within the injecting fuel container 10, is set to be higher than the pressure of the compressed gas G, which is sealed within the fuel containers 1 and 1'. Thereby, the fuel F can be sufficiently injected into the fuel container 1 or 1', even if the amount of fuel F remaining in the injecting fuel container 10 becomes low.

The valve mechanism 14 is basically of the same construction as the valve mechanisms 4 illustrated in Figure

2A and Figure 2B. However, the tip of a valve stem of the valve mechanism 14 protrudes outward, and is configured to press the valve stem 43 of the valve mechanism 4, thereby opening the fuel flow path thereof to inject the fuel F.

The resistance mechanism 15 prevents ejection of the fuel F due to inadvertent opening of the valve mechanism 14. The resistance mechanism 15 is constituted by a cylindrical wall formed about the periphery of the valve mechanism 14, for example. The resistance mechanism 15 is designed so as not to be impeded by the injection valve 5 or the valve mechanism 4 when reinjecting fuel into the fuel container 1 or the fuel container 1'.

The injecting fuel container 20 illustrated in Figure 5 according to the fourth embodiment of the present invention is manually operated, and no compressed gas is sealed therein. The injecting fuel container 20 comprises: a cylindrical container main body 21; a piston shaped extruding member 22, which is manually operated to slide within the container main body in an airtight manner; a valve mechanism 23 (nozzle mechanism), provided at the tip of the container main body 21; a lid member 24, for sealing the end of the container main body 21 opposite that of the valve mechanism 23; and a resistance mechanism 25. Fuel F is suctioned into the container main body 21 by retracting the extruding member 22. The fuel F is pressurized by advancing an operating section 22a of the extruding member 22, and injected into the inner container 3 of the fuel container 1 or 1', via the valve mechanism 23.

Engaging protrusions 21a are provided at portions of the container main body 21 that link with the lid member 24. The engaging protrusions 21a function to prevent the lid member 22 from being disengaged from the container main body 21, in case that fuel remaining in the fuel container 1 or 1' flow into the container main body 21 when the injecting fuel container 20 is connected thereto.

The parts that contact the fuel F of the injecting fuel

containers 10 and 20 are also formed by non-metallic materials, that is, resin. Thereby, contamination of the fuel F by metallic ions is prevented. In addition, the container main bodies 12 and 21 are formed by transparent materials, to enable visual confirmation of the contents thereof. Further, the shapes of the container main bodies 12 and 21 can be designed as desired, taking fuel capacity, portability, and the like into consideration.

PE, PP, AS, ABS, PAN, PA, PET, PBT, PC, POM, PEN, and the like may be the resin to be employed as the material of the parts that contact the fuel F in the fuel containers 1, 1′ and the injecting fuel containers 10, 20. The material is selected on the basis of the intended contents, strength of the material, and the like. For example, if resistance against methanol is taken into consideration, polyethylene (PE), polypropylene (PP), polyethylene naphthalate (PEN), and poly acrylo nitrile (PAN) are superior and preferred. Acrylonitrile butadiene styrene (ABS), polyamide (PA), or polyacetal (POM) may also be employed. If resistance against ethanol is taken into consideration, polyethylene (PE), polypropylene (PP), polyamide (PA), polyacetal (POM), polyethylene naphthalate (PEN), polyethylene terephthalate (PET), and poly acrylo nitrile (PAN) are superior and preferred. Acrylonitrile butadiene styrene (ABS) may also be employed.

If resistance against dimethyl ether is taken into consideration, crystalline resins, such as polyamide (PA), polyacetal (POM), poly butilene terephthalate (PBT), and polypropylene (PP) may be employed. Alternatively, non-crystalline resins, such as acetal, polycarbonate, and acrylo nitrile butadiene styrene, may be employed to form the parts, and the surfaces thereof may be coated with epoxy resin or polyamide resin.

A single layer structure, formed by a single material, or a double (multiple) layer structure, formed by a plurality of materials, may be employed. In the case that the double layer

structure is employed, a material having superior resistance is employed for the inner layer that contacts the contents, and a pressure and shock resistant material is employed as the outer layer. Fuel containers employing the double layer structure may be formed by a double injection molding method, or by a coating method.